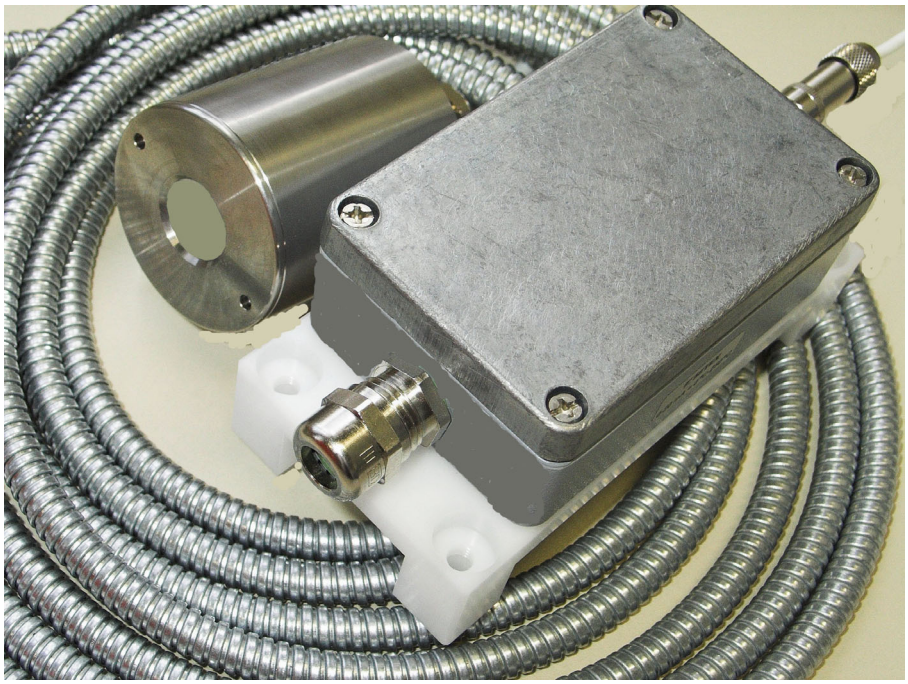

Thermophil® INFRA R271

Operating instructions

BA 070705

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Contents

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1 Device description

1.1 Properties and fields of use

Properties

INFRA radiation sensors of the type R271 are stationary and robust measuring sensors for contactless temperature measurement under high ambient temperatures.

This technology is very advantageous as the sensor can be installed near the measured object. The sensor does not need to be cooled.
This is why in the system technology no additional openings and cross-flow blowers are required. This results in a significant cost reduction.

The measuring cell transforms the collected absorbed radiation energy into an electric signal which is then processed in a microprocessor.

The influence of the ambient temperature on the measuring cell is compensated.

Fields of use

Due to the properties mentioned above, the measurement sensors of the type R271 can even be applied in places where other measurement systems fail because of unfavourable ambient conditions, such as in:

continuous furnaces for lacquer drying, textile and paper drying etc.

The contactless measuring principle makes especially sense if the measured object either has a low heat conductivity or is in movement or if a quick measurement is required.

To protect the measuring cell against dust, vapours and other environmental influences, the measurement opening of the sensors is secluded by a silicon window. If it is steamed up or dirty, it can be cleaned without any problems.

The quite small design of the measuring head permits mounting even under extremely narrow space conditions.

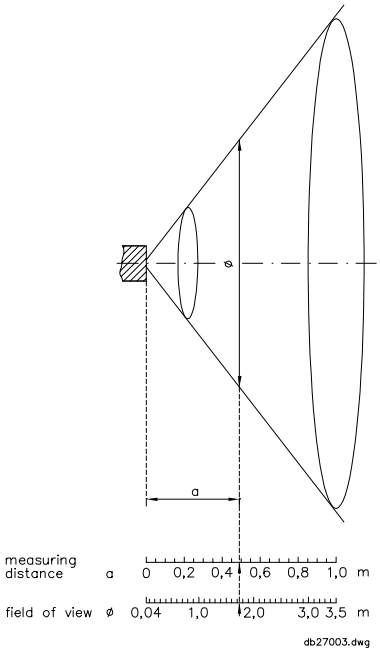
The connection cable of the sensor is also suitable for high ambient temperatures. In addition, the connection cable is protected against mechanical damages by means of a metal hose.

Scope of delivery
- Sensor consisting of sensor head and measuring amplifier
- Operating instructions

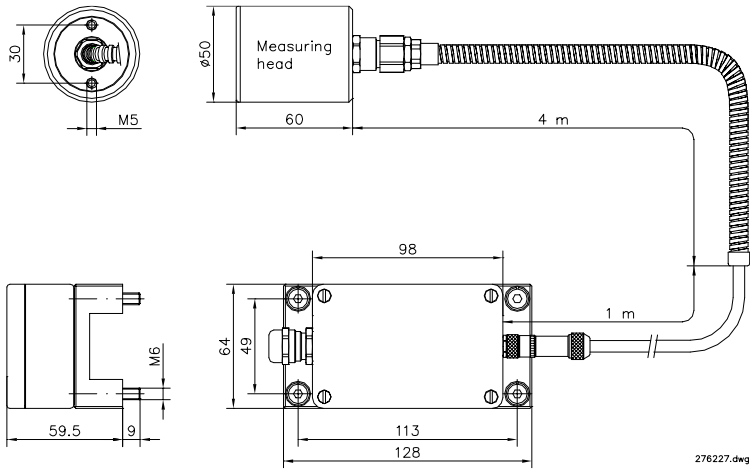
1.2 Technical data

Technical data of evaluation electronics		
Input	Measuring head pluggable	
Interface	HART® protocol (FSK BELL 202, 1,2 kb/s)	
Functions (can be configured via HART® interface)		
Dimension	°C or °F	
Minimum and maximum values of measurement range	0 ... 250 °C (32 ... 482 °F)	
Emission factor	0,1 ... 1	
Transmission factor	0,1 ... 1	
Ambient temperature alarm	20 ... 250 (default 250 °C) (68 ... 482 °F)	
Damping	0 ... 999,9 s	
Maximum mode	0 ... 999,9 s	
Minimum mode	0 ... 999,9 s	
Fault current	3,9 ... 21,5 mA	
Fieldbus address	0 ... 15 (0 = point to point, 1 ... 15 multidrop)	
Analog output		
Output signal	4 ... 20 mA, linear	
Permissible load	≤ 500 Ω for standard version/U_H = 24 V	
Precision		
Measuring precision	≤ 2 % of measuring range	
Response time	$t_{0,9}$ = 6 s (without damping)	
Auxiliary energy		
U_H = DC 12...30 V ,max. 23 mA, residual ripple ≤ 150 mV eff.		
Connection		
2 screw clamps 1.5 mm², I+, I-		
Ambient conditions	**Evaluation electronics**	**Measuring head with cable**
Permissible working temperature	0 ... + 70 °C	0 ... +250 °C
Permissible storage temperature	-10 ... +70 °C	-25 ... +250 °C
Climatic class	KWS in accordance with DIN 40040	
Mechanical data		
Casing material	Aluminium diecast	Stainless steel
Weight	350 g	1200 g
Protection type	IP 65	
Cable length	5 m	

Measuring field characteristics



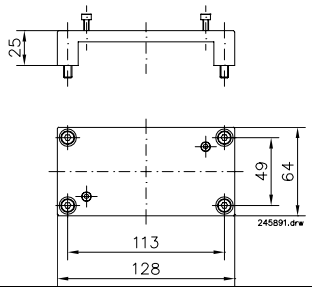
Dimensions



Ordering details

Designation	Ordering no.
Thermophil® INFRA, type R271	276227

1.3 Accessories

Designation	Type	Dimensions	Ordering no.
HART® modem incl. software 	R 300-107		220930
Mounting plate for TR40-10 	R300-112		245891
Power supply unit 230 V, output 24 V DC in topside housing 	5906-4		U8901159064
Power supply unit 230 V, output 24 V DC in mounting rail housing 	5906-3		U8901159063

2 Safety precautions

The devices have been produced in line with the regulations currently in force and have left the factory in perfect condition after thorough tests of the safety and the guaranteed device properties. Please follow the instructions provided with regard to installing and operating the equipment.

2.1 General information

- Please read the operating instructions prior to installing and starting up the equipment. Should you have any questions or difficulties, please contact our service staff.
- Thoroughly instruct your operating and maintenance staff and provide them with all the information they need.
- The equipment's internal self-monitoring systems and fault messages do not replace the safety facilities in the overall system into which the unit is integrated.
- Make sure that all regulations relating to the operation of your system are observed.
- The equipment must be installed and maintained by qualified technical personnel.
- Make sure that the data and operating conditions specified by BARTEC are observed.

2.2 Mounting site

- When installing the equipment, make sure that you observe the permissible climatic and temperature conditions in line with the technical data.
- If exceptional conditions exist at the mounting site, suitable measures must be taken to protect the equipment (cover, cooling, heating). Please also have a look at the accessories we offer with respect to this.
- Select a vibration-proof mounting site for the device.
- Avoid a mounting site near any equipment that generates electromagnetic fields (transformers, motors, power lines, magnets, semiconductor actuators, high-frequency generators and the like).
- The sensors should be installed in a location separated from protective circuits wherever possible.
- If due to the local circumstances inductive consumers such as contactors, solenoid valves and the like are installed nearby, interference in the contactor coil should be suppressed by using an RC circuit. Manufacturers of this equipment usually offer appropriate suppressor accessories.

2.3 Electrical connection

- Before connecting the equipment, check whether the rated voltage specified on the type plate corresponds to the voltage available at the installation location.
- The wiring must be carried out by trained specialists.
- Lay sensor and signal cables in a sufficient distance to live wires or to wires with high electromagnetic interference potential, in separate cable ducts if possible. Lay sensor and signal lines at a sufficient distance from live lines, in separate cable ducts wherever possible.

2.4 Operate the device

- Before switching on the auxiliary power, make sure that the permissible operating voltage of the device is not exceeded.
- For the power supply, use only a direct current voltage source with a residual ripple below a maximum of 150 mV rms effective.
- Make sure that the sensor head does not exceed the permissible operating temperature during operation.
- During measurement operation, make sure that the radiation entrance point is kept clear. The solid disc or the lens must not be clouded by splashed water or condensed water and must not have any deposits of dirt.
- In the event of faults, first determine whether you can repair them yourself. If this is not possible, switch off the equipment and send it to BARTEC for repair, together with a precise specification of the fault.
- If you discover any signs of damage or destruction to any parts of the equipment or if safe operation of the equipment cannot be guaranteed for any other reason, do not start up the equipment or, if already in operation, shut it down immediately. Notify the local service centre.
  Make sure that the equipment cannot be switched on again until the damage has been repaired.
- Contact our service specialists if you discover any faults or defects during operation or if you have cause to doubt that the equipment is working properly.

Disclaimer of liability

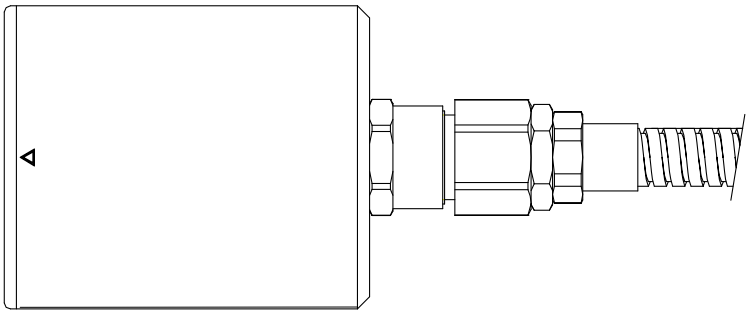
BARTEC GmbH and its vicarious agents only assume liability in the case of deliberate acts or gross negligence. The extent of liability in such a case is limited to the value of the order placed with BARTEC GmbH.

BARTEC accepts no liability for any damage resulting from non-observance of the safety regulations or from non-compliance with the operating instructions or operating conditions. Secondary damage is excluded from the liability.

3 Installation

3.1 Mounting site

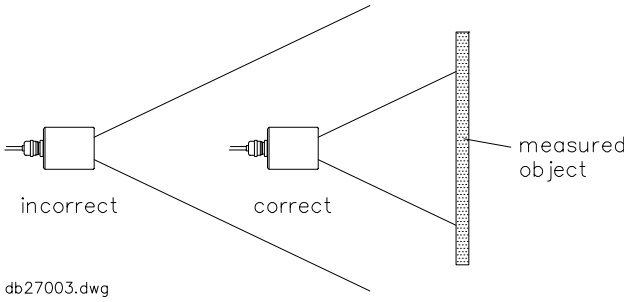
- The ambient conditions at the mounting site must be within the admissible temperature and climate ranges. For the corresponding data, see 1.2 Technical data.
- The mounting site should be vibration-proof and free of electromagnetic interference fields. Please also see the instructions under 2.
- When selecting the mounting site, make sure that the permissible operating temperature for the respective sensor (temperature of sensor casing) is adhered to (see 1.2).
- Consider with the installation of the sensor the situation of the installation marking. This should always point to the same point of reference.



3.2 Measurement distance

In the radiation measurement, the laws of optics have to be taken into account. Depending on the distance between the radiation sensor and the measured object there will be certain minimum measuring field diameters – see distance ratio (Technical data).

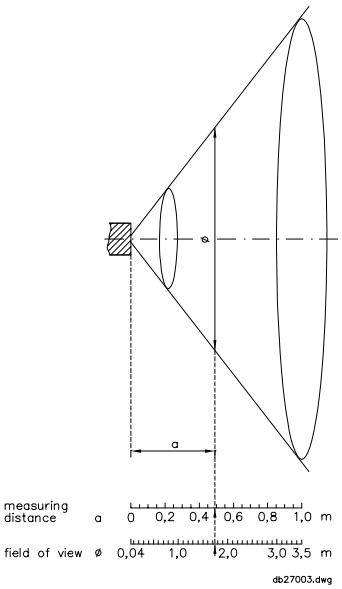
The respective sensor type required, with the appropriate focal length, must be determined in accordance with the required measuring field size at the measurement object and the possible measurement distance. In order to avoid incorrect measurements, the measured object must fill the entire field of view of the sensor lens. The lens field of view must therefore be no larger than the measured object itself.



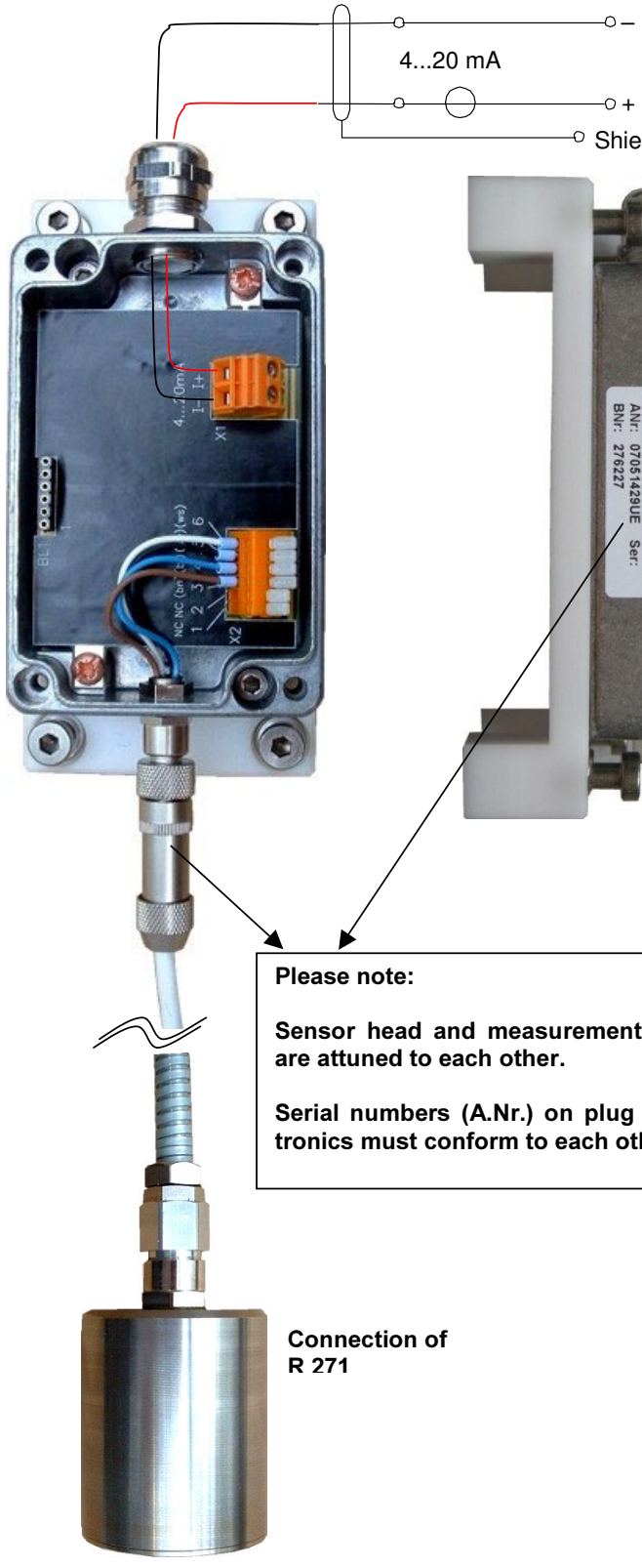
The temperature of a panel of fabric which is 1m wide shall be measured with a radiation sensor of the type R271.

At what distance must the sensor be mounted?
The measuring field diagram for sensor type R 271 shows that for a measuring field diameter of 1 m, a measuring distance of approx. 270 mm applies.

Consequently the distance between the sensor and the measured object should be maximally 270 mm.



3.3 Connection



Connection of sensor		
Pin	Signal	Colour
1	-	-
2	-	-
3	R+	bn
4	R-	bl
5	U-	bk
6	U+	wt

Please note:

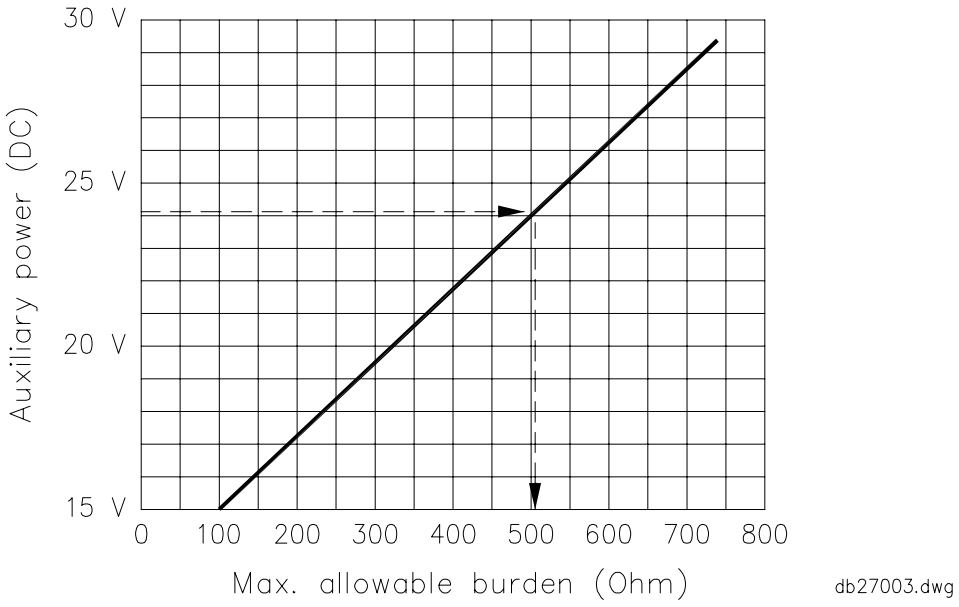
Sensor head and measurement amplifier are attuned to each other.

Serial numbers (A.Nr.) on plug and electronics must conform to each other.

Connection of R 271

For the connection, do not exceed the maximum permissible load at the sensor output.
The overall resistance of the connected devices and cables must not exceed the maximum value shown in the diagram. This value depends on the auxiliary energy that is applied.

Example *For a voltage supply of DC 24 V, a maximum load of 500 Ω is permitted..*



4 Operation

4.1 Measurement mode

Once the auxiliary energy has been switched on, the measurement operation can be commenced.
Further operation depends on the respective application of the sensors. Please observe the operating instructions of the connected device (e.g. display, recorder, controller).

Please observe the following issues during measurement operation:

- The sensor's measurement opening must be clean. Dust deposits or moisture may falsify the measured values and must therefore be removed.
- Precision specifications are only valid for the measurement range specified on the sensor.
- The radiation sensors must not be subjected to any radiation that is far above the largest measurement range value for the series in question (approximately 30 %). It is important that the radiation sensor does not exceed the permissible operating temperature.
- Please also heed the safety precautions in section 2.

4.2 Configuration

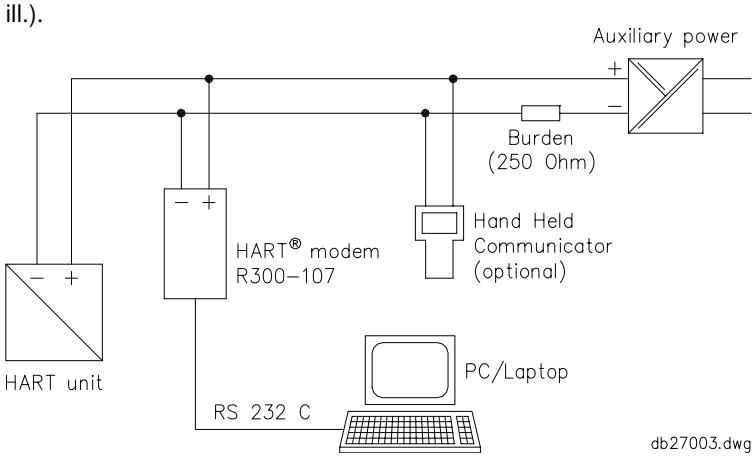
Under certain operating conditions it is required to carry out or to change certain settings. The configuration takes place via an interface with HART® protocol.
To change parameters, a HART® programming device or an adequate PC software has to be used. The HART® commands are described under 6.

4.2.1 Configuration with HART® modem type R 300-107

Radiation sensors not operated with a transmitter equipped with a display are configured by means of the HART® modem R 300-107 and a PC software supplied together with the device.

4.2.1.1 Connect the HART® modem

Connect the modem in accordance with the supplied documentation (see ill.).

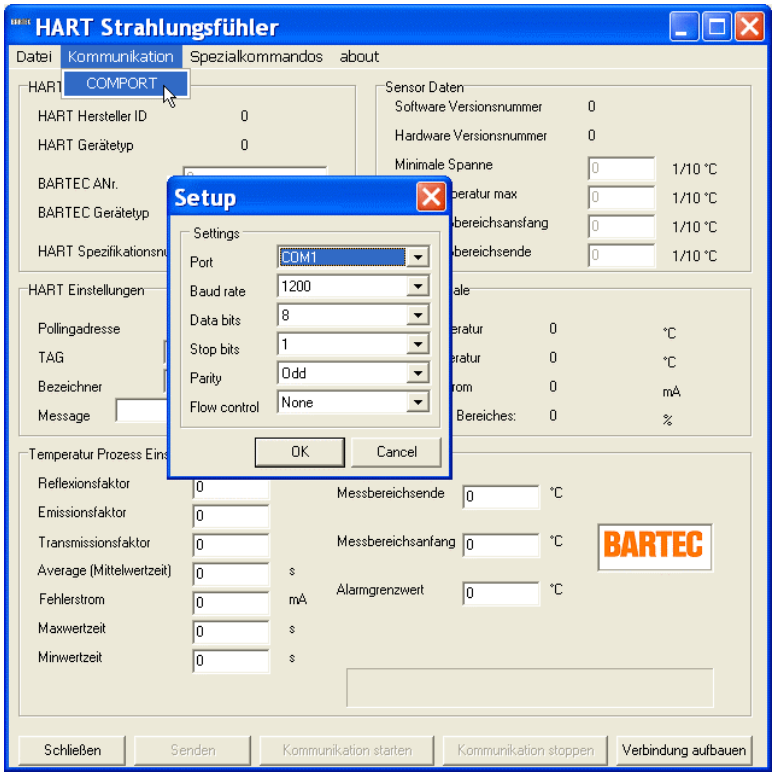


4.2.1.2 Software

- Install the software ”HART infrared configurator“ that is supplied together with the HART® modem.

- Start the software “HART infrared configurator“.

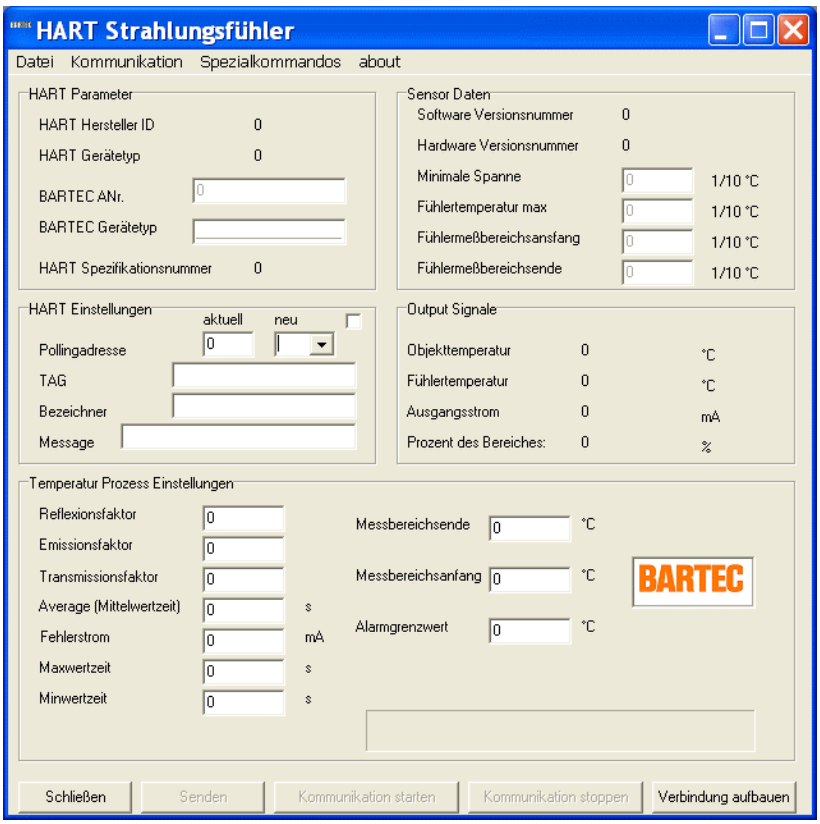
Adjust the interface parameters in accordance with the illustration below. Select the interface the HART® modem is connected to.



- Click [Establish connection].

Change parameters

After the connection has been established, the parameters of the connected HART® device are read and displayed.



Click [Send] to write changes of parameters into the sensor.

5 Maintenance

The maintenance of the radiation sensor is restricted to checking the lens on dirt and cleaning it if required.

Dirt has negative effects on the measuring precision!

Cleaning the lens

Clean the lens very carefully by absolutely avoiding scratches on the lens surface!

- First blow away any loose particles with clean air.
- If any particles remain, remove them carefully by using a soft lens brush.
- Remove any more tenacious dirt using a clean, soft, lint-free cloth that has been moistened with distilled water.
- The best way to remove fingerprints and grease is to use a cotton bud or a piece of cotton wool. To do this, moisten the cotton wool with a little spirit, technical alcohol or lens cleaner.
- Silicone, which may also be contained in hand creams, should be removed carefully by using hexane.
- Do not wipe the lens surface dry. Instead, leave the cleaning agent to evaporate.

Never clean the lens using ammonia or cleaning agents containing ammonia. This might cause permanent damage to the lens!

6 HART® protocol

The table below offers an overview of the relevant HART® commands of the HART® revision 7.

No. and function		Data in the instruction	Data in the reply
0	Read unique identifier		
1	Read primary variable		Byte Range unit code Float PV
2	Read current and percent of range		Float Current Float Percent of range
3	Read current and four (predefined) dynamic variables		Float Current (present output current) byte Range unit code float PV (object temperature) byte Range unit code float SV (present casing temperature UT) byte Range unit code float TV (object temperature prior to damping) byte Range unit code float VV (object temperature prior to min/max value)
6	Write polling address	Byte HART address Byte Loop Current Mode (not introduced)	Byte HART address Byte Loop Current Mode (not introduced)
8	Read Dynamic Variable Configuration		
11	Read unique ident. associated with tag		
12	Read message		
13	Read tag, descriptor, date		
14	Read PV sensor information		
15	Read output information		
16	Read final assembly number		
17	write message *is only stored in RAM!*		
18	write tag, descriptor, date		
19	Write final assembly number *is only stored in RAM!*		

No. and function		Data in the instruction	Data in the reply
34	Write damping value für die PV	float average value 0 … 999.9 s	float average value 0 … 999.9 s
35	Write range values für die PV	byte range unit code float upper range value (MBE) float lower range value (MBA)	byte range unit code float upper range value (MBE) float lower range value (MBA)
38	Reset "config changed" flag		
40	Enter/exit fixed current mode Loop test (fix the analog current at specified value)	float current (0 = exit fixed current mode)	float current
128	Read Emissivity		float Emissivity
129	Write Emissivity	float Emissivity 0.100…1.000	float Emissivity
130	Read Reflectivity		float Reflectivity
131	Write Reflectivity	float Reflectivity 0.100…1.000	float Reflectivity
132	Read Transmissivity		float Transmissivity
133	Wirte Transmissivity	float Transmissivity 0.100…1.000	float Transmissivity
134	Read error current		float error current [mA]
135	Write error current	float error current	float error current [mA]
136	Read max/min hold time		float Max hold time [s] float Min hold time [s]
137	Write max/min hold time	float Max hold time 0.0 … 999.9 s float Min hold time 0.0 … 999.9 s	float Max hold time [s] float Min hold time [s]
138	Read alarm values		float Alarm value [°C]
139	Write alarm values	float Alarm value [°C]	float Alarm value [°C]
144	Special command (only read) *see description*	float value 1 float value 2	float value 1 float value 2
145	Special command *see description*	float value 1 float value 2	float value 1 float value 2

No. and function	Data in the instruction	Data in the reply
146 Read factory settings and write into EEPROM	int password password [32] >nur RAM password [34] >EEPROM	Int success report (0 = error; 1 = ok)
148 Read device data		long ANr char[15] type int software version

Description of command 144

Command	Data in instruction float float	Data in reply float float
144	0 does not matter display service register no. 0	0 Content of service register
144	1 does not matter display service register no. 1	1 Content of service register
144	2 does not matter display service register no. 2	2 Content of service register
144	3 does not matter display service register no. 3	3 Content of service register
144	4 does not matter display service register no. 4	4 Content of service register
144	5 does not matter display service register no. 5	5 Content of service register
144	6 does not matter display service register no. 6	6 Content of service register
144	7 does not matter display service register no. 7	7 Content of service register
144	8 does not matter display service register no. 8	8 Content of service register
144	9 does not matter display service register no. 9	9 Content of service register

Description of command 145

Command	Data in the instruction float float	Data in the reply float float
145	0 value describe service register no. 0	0 Content of service register
145	1 value [0-65536] describe service register no. 1	1 Content of service register
145	2 value [0-65536] describe service register no.2	2 Content of service register
145	3 value [0-65536] describe service register no. 3	3 Content of service register
145	4 value [0-65536] describe service register no. 4	4 Content of service register
145	5 value [0-65536] describe service register no. 5	5 Content of service register
145	6 value [0-65536] describe service register no. 6	6 Content of service register
145	7 value [0-65536] describe service register no. 7	7 Content of service register
145	8 value [0-65536] describe service register no. 8	8 Content of service register
145	9 value [0-65536] describe service register no. 9	9 Content of service register Upon error: 999990 = checksum incorrect
145	10 value [0-65536] Check sensor data and write to EEPROM Password [34]	10 Content of service register Upon error: 999990 = checksum incorrect 999991 = errors when writing to EEPROM
145	146 value [0…65536] read factory settings and write to EEPROM password [32] >only RAM password [34] >EEPROM	146 Return value 0 = error 1 = ok

Annex

Emission factor

For the contactless temperature measurement of an object, knowledge of the emission degree ”E“ is required and has to be integrated in the measurements. The calibration basis for IR temperature measurement and control devices is the black body with emission degree E = 1.

Detect the actual E factor

The emission factor depends on the material and its surface structure. For theoretical values, refer to the relevant literature.
As the E factor also depends on the wavelength, the temperature and the direction of the output beam, the values given in the table can only be used as rough reference values, e.g. for project planning. In general, raw, mat or oxidized surfaces have a higher E factor than shining materials.

Table: Emission factor E at room temperature

Surface	Temperature (°C)	E factor
Asbestos slate	20	0,93
Bakelite varnish	80	0,935
Lead, oxidized	200	0,63
Chrome-nickel, oxidized 20 Ni 25 Cr 55 Fe	200	0,90
Chrome-nickel, oxidized 20 Ni 25 Cr	500	0,97
Chrome-nickel, oxidized 60 Ni 12 Cr 28 Fe	270	0,89
Roofing felt	20	0,93
Ice, smooth, water layer	0	0,966
Ice, rough surface	0	0,985
Enamel, white / porcelain	20	0,9...0,92
Iron, oxidized	100	0,74
Iron, oxidized	500	0,84
Iron, rusty	25	0,85
Iron, rolling skin	20	0,77
Plaster	20	0,85
Glass	20...90	0,94
Graphite	20	0,45
Rubber, soft, grey	25	0,86...0,94
Rubber, hard	25	0,955
Skin, dry	30	0,96
Radiator varnish, oil paint	85	0,925
Wood (beech)	20...70	0,915
Plastics (PVC, PTFE, PE at thicknesses of 0.4 mm and more)	20...150 20...130	0,91 0,77
Copper, oxidized	20...120	0,96
Mat varnish, e.g. 3 M 1020	200...600	0,60
Brass. oxidized	20	0,85
Papeer	40...400	0,79...0,94
Steel, rough	70	0,91
Clay, baked	20	0,93
Brick, mortar, plaster		

In practice, it is recommended to verify the E factor once by taking a comparison measurement. Various measurement procedures may be suitable depending on the circumstances.

Contact-based measurement:
Measure the surface temperature of the measurement object with a contact sensor, for instance a low-mass thermal spiral or band element. This method cannot be used for substances with a very poor thermal conductivity, though

Convection measurement:
If it is not possible to take a contact-based measurement because the measurement object is moving extremely quickly (as may be the case for calenders or rollers for instance), a roller sensor working in accordance with the convection principle can be used. The large time constant of the sensor must be taken into account but it does not interfere with this one-off measurement.

Test method:
If you blacken part of a material sample (e.g. with Velvet Coating from 3M) and then, for instance, heat it up in a climatic test cabinet, you can take a differential measurement to establish the exact value of the emission factor. In other words, with the E factor set to 1, you take a measurement on the blackened part and then take a measurement on the part that has not been blackened. By changing the E factor, you set the same display as before and can now read the E factor on the E regulator.

Transmission factor

The transmission factor specifies the percentage of radiation that passes an additional protective window.
If you do not have the details of the transmission factor for the protective window used, you can define the transmission factor yourself.

Determine the transmission factor

- Measure the temperature of the measured object with the sensor head, without using the protective window. When you do this, make sure that the correct emission factor is set.
- In the configuration, enter transmission factor 1,000.
- Insert the protective window.
- Change the transmission factor in the configuration and repeat the measurement. Compare the measured temperature with the temperature that was measured without the protective window.
- Keep repeating this process until the temperature displayed is the same as that displayed for the measurement without the protective window.

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